NATIONAL TRANSPORT RESEARCH CENTRE
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THE EFFECTS OF ROAD WORK SIGNS ON DRIVER BEHAVIOUR

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C O N T E N T S

1. INTRODUCTION

In 1981, the National Transport Research Centre (NTRC) of Pakistan and the Transport and Road Research Laboratory(TRRL)of the United Kingdom (UK) agreed to carry out a collaborative programme of road safety research. One of the studies included in the programme was the measurement of skid resistance at a number of urban and rural sites. In order to carry out this work safely, it was decided to use a signing procedure similar to that used in the UK to warn drivers of work on the road ahead.

At the time of the study, it was common for drivers in Pakistan to be given little or no such warning.Usually when road works were begun the labourers placed a few rocks in the road to mark the beginning of them and only occasionally were a sign board and/or red flags included.

At the most only drivers driving on the same side as the obstruction were given this redimentary warning. Drivers approaching from the opposite direction were not considered.

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It would seem likely that such inadequate signing of road works would cause dangerous conditions for drivers and result in a number of road accidents. In Islamabad in 1981, a number of road accidents occurred (including at least one fatal) due to diversions of traffic because of road works.

If, instead, a sequence of signs was to be set up in both directions from road works and cones were to be used to divert traffic, then it may be possible to prevent such accidents from occurring. However, it seems likely that such signs would only be effective if they caught drivers attention and if drivers understood their meaning.

Research with bus drivers in Pakistan[1] indicated that their knowledge of road signs was quite good as the drivers on average gave correct answers to 23 out of 27 signs. However, other research carried out in Pakistan suggested that many drivers did not obey traffic signs. For example, at some sites in Islamabad 100 per cent of drivers approaching stop signs failed to stop at the intersection.

Also studies in other countries[2,3,4,5,6,7,8] have demonstrated that drivers are often poor at registering road signs (some signs were only noticed by 5 per cent of drivers) even when tested less than 1 minute after passing the signs.

Therefore, this study was carried out to see whether the new road work signing procedure adopted when measuring skidding resistance was noticed by drivers and whether it resulted in changes in driver behaviour.

The precise objectives of the study were as follows:

(1) To determine whether there were any changes in approach speeds and overtaking levels after the signs and cones were installed.

(2) To determine what factors related to changes in approach speed and overtaking levels.

(3) To determine what proportion of drivers noticed the road signs relating to the road works.

(4) To determine what factors were related to the drivers recognition levels of the signs.

(5) To determine what proportion of drivers knew the meaning of the signs.

(6) To determine what factors were related to the drivers knowledge.

2. METHOD

The layout of the signs and cones to be used at each of the 32 sites where skidding resistance was to be measured is shown in Fig. 1. In all, 5 different signs were used on each side of the road and the road works warning sign was repeated with "End" in Urdu.

The distances between signs varied according to the conditions at each site, the biggest gaps being at locations with high speed traffic. Each sign was designed according to the details given in the Pakistan Highway Code[9] and was painted onto a sheet of white plastic which was fixed to a portable stand (see Fig. 2). The top of each sign stood approximately one Meter above the ground when the stand was placed at the road side. The cones were placed in the road at a maximum of 1-2 meters from the road's edge and were positioned along the road for upto 30 Meters. Only at one site did the obstruction caused by the cones impede two way traffic.

At all the sites, the skidding resistance was measured on both sides of the road but usually the survey relating to the signs was carried out for the first side measured. At the 32 sites, drivers travelling along the same side of the road as the cones were stopped by a policeman within 400 Meters of the last sign. Only one driver was stopped at a time. After the driver had been stopped, a trained interviewer asked him to identify the signs he had just passed from a chart (see Appendix 1) containing 10 signs. He was then requested to explain the meaning of each of the 10 signs. In addition, the interviewer asked the driver to rate the signs overall on a 4 point scale from very good to very poor and information was also collected on the type of vehicle driven, ownership status, driver nationality, readership of the highway code and the age when the drivers had finished their full time education. In total 903 drivers were interviewed.

At 29 of the 32 sites vehicle approach speeds (only those approaching from the obstructed side) were measured using a radar speed meter for 30 minutes before and 30 minutes after the cones and signs were installed. A total of 5,850 vehicle speeds was recorded.

At 30 sites, the number of vehicles overtaking other moving vehicles within the 'No Parking' area was recorded for the same 30 minute periods before and after the signs and cones were installed. Two of the 32 sites were excluded because of non-availability of survey staff.

3. RESULTS AND DISCUSSION

3.1. Vehicle Speeds and Overtaking Levels:

The average approach speed at 29 sites was reduced from 50.7 kilometers per hour (kph) to 43.9 kph after the signs and cones were installed.

From Table-1, it can be seen that these reductions for different vehicle types were not statistically significant* (T tests) at every site. Also it would appear that motor cycle speeds were less affected than those of other vehicles as there were only 11 sites where statistically significant reductions in their speeds were observed (this may in part be due to the small sample of motor cycles obtained which would necessitate very large changes in speed to reach statistical significance). Also it is probable that motor cycle riders would be less likely to reduce their speeds

*The terms 'statistically significant' is used when the probability of a difference occurring by change has been determined as 1 in 20 or less by a statistical test.

for relatively small obstructions.

The latter explanation is supported by Figure 3 which shows that the percentage reduction in speed was lowest for motor cycles on both rural and urban roads. The figure also clearly demonstrates that the percentage reductions in speeds were much greater on rural roads than urban roads for all vehicles except trucks.

From Table 2, it can be seen that the effects of site(urban vs rural roads), vehicle type,and the introduction of signs and cones on vehicle speed were all statistically significant (analysis of variance). This was also the case for the two way interactions which indicates that the effects of these 3 factors on speed were not consistent, for example, the reduction of speeds after the introduction of the signs and cones varied with different types of vehicle and also was different for urban and rural sites. This is more clearly illustrated in Table 3 where a detailed breakdown of mean vehicle speeds by the 3 factors is given. The presence of the signs and cones resulted in statistically significant reduction (T tests) in mean speeds for all vehicle types on both urban and rural roads except for motor cycles where there was no change in speed.

It is interesting to note that rural roads (before the signs were set-up) the mean speeds of passenger carrying wagons (Ford Transits used as mini buses) and buses were not much different from those of cars and at the urban sites wagons were the fastest vehicle type. At the rural sites it was found that just over a quarter of the wagons and buses

were violating the speed limit of 65 kph (see Fig 4). At urban sites the percentages of violations were much lower (0-8 per cent) both before and after the signs and cones had been installed.

A regression analysis was carried out to determine what factors other than site (urban vs rural) and vehicle type were related to the reduction in vehicle speed after the signs and cones were introduced. Included in this analysis were the data collected from the driver interviews.

The following equation was found to explain 69 per cent of the variance in the reduction in mean vehicle speed at each site:

$$\text{Reduction in speed} = 0.4_2 \text{ Initial speed} - 0.014 \text{ Flow} - 9.21 \quad (R^2 = 0.69,\ F = 29.2)$$

The equation indicates that reductions in mean vehicle speeds were greater at those sites with higher mean speeds before the signs and cones were installed and at those sites where traffic flows were lower. Having taken these two variables into account none of the factors calculated from the interview data such as the number of signs correctly identified at each site was found to be related to the reduction in speed.

3.2. Changes in overtaking levels

Over all the 30 sites, overtaking levels dropped from 16.6 per cent to 10.7 per cent after the installation of 'No Overtaking Signs'. However, inspite of this drop, there was still a high proportion (up to 25 per cent) of drivers dis-obeying the signs.

A regression analysis of site variables (that is average speed before and during the signs, overtaking levels before and during the signs, the percentage of vehicles that were trucks and buses, and the variables from the interview data as listed above) indicated that the best predictor of changes in levels of overtaking at different sites was the initial level of overtaking at each site. The equation produced by the analysis is given below :

$$\text{Change in percentage overtaking} = 0.415 \times \text{Initial overtaking level} + 0.113$$
$$(R^2 = 0.41,\ F = 16.7)$$

This equation explained 41 per cent of the variance in the dependent variable across the 30 sites. The only other variable found to be related to the change in levels of ovdrtaking was the percentage of vehicles that were trucks and buses. The sites with little change in overtaking

levels were those where the traffic contained relatively high proportions of trucks and buses. These were also the sites where the initial overtaking levels were low(around 10 per cent).

No other factors were found to be related to the changes in the levels of overtaking. In particular, differences between sites in the proportions of drivers identifying or knowing the meaning of the 'no overtaking' sign could not be linked to difference in the changes in overtaking levels.

3.3. Recognition of the signs

On average the drivers correctly identified half the signs displayed at the road works from the chart of 10 signs. There was evidence that many of the drivers were resorting to guessing some of the signs as, on average, each one of the 5 incorrect signs (those not displayed at the road works) was picked out by 19.4 percent of the drivers. The mean number of signs correctly identified after correcting for guessing (the number correctly identified - the number wrongly identified) was 1.8

The identification levels for each of the 5 signs are shown in Figure 4. The direction sign was better remembered than the others, possibly because it may have been more conspicuous as it was the only sign placed in the road and possible because it appeared to have the simplest design.

The 'no overtaking' sign was the worst remembered of the 5 and, if one estimates that 20 per cent of the drivers picked it out as a guess, then only 15 per cent truly recognized the sign. Since very few drivers identified this sign, it is perhaps not surprising that many drivers overtook in the 'no overtaking' zone.

Other studies[4,6] in Sweden and Finland found that mandatory signs (speed limits) were better noticed than warning signs. This would not appear to be the case in Pakistan.

3.4. Factors related to sign recognition

An analysis of variance (one way) of identification scores (corrected and uncorrected scores tested separately) by six variables revealed that the scores were related to 4 of them, that is the site, readership of the Highway Code (whether or not drivers said they had read it), the drivers' attitudes to the signs and their education but not to the type of vehicles driven nor to the owner/professional status of the driver.

The range of scores for different values of these 4 variables is shown in Table 4. The variable with the widest

range was site i.e. the mean number of signs identified per driver varied considerably from one site to another. To investigate these site differences the relationships between the following variables and the mean identification scores(both uncorrected and corrected for guessing) at each site were examined:

Site variables:

1. Presence or absence of traffic control or roundabout
2. Presence or absence of traffic control (signals or roundabout or railway level crossing)
3. Presence or absence of junction
4. Urban or rural road
5. Average vehicle speed after signs installed
6. Vehicle flow per hour
7. Percentage of vehicles overtaking in 'no overtaking' zone
8. Percentage of drivers who had read the Highway Code
9. Percentage of drivers who had been to school
10. Percentage of drivers who said the signs were very good.
11. Percentage of vehicles which were buses or trucks.

The differences between the scores (both corrected and uncorrected) at the various sites was found to be dependent (using t test) upon whether or not some or of traffic control was present close to the site (ie the first 2

site variables) but the differences were not related to any of the other 9 site variables. Average scores (out of 10) were generally about 0.5 lower at sites close to traffic signals, roundabouts or level crossings than at other sites. This is not surprising as it is likely that drivers would need to give more attention to the control ahead at the former sites and therefore spend less time looking at the signs.

3.5. Knowledge of signs

From Fig 6 it can be seen that the best known sign was the 'stop' sign. As this is probably the most common road sign in the Islamabad Rawalpindi area the result is not unexpected. The other signs, although they are given in the Pakistan Highway Code, were rarely used in the study area and it is therefore not surprising that knowledge of these signs was not very good (the average number of signs known by the drivers was only 5.3 out of 10). The differences in the percentages of drivers knowing each sign may not only reflect differences in knowledge but it is also likely that they reflect differences in the ease with which drivers were able to guess the meaning of the signs. Ideally signs should be designed so that their meaning is obvious and, although this may not be easy to do for all signs, the results indicate that there is a need for sign design improvement as well as a need for improved driver knowledge in Pakistan.

3.6. Factors related to sign knowledge

An analysis of variance (one way) of drivers' knowledge of the 10 signs by six driver variables(shown in Table 5) indicated that drivers' scores out of 10 were related to each of them. Drivers who held professional licences, drove buses or trucks, had not been to school and thought the signs were poor knew fewer signs than drivers with the opposite characteristics.

A stepwise regression of drivers's knowledge score on 4 variables (education, professional/owner driver, read/not read Highway Code and type of vehicle driven) produced the following equation:

$$\text{Knowledge} = 0.612\ \text{Education}^* + 0.794\ \text{Read Highway Code}^* + 0.2112\ \text{owner driver}^* + 4.0802$$

$$(R^2 = 0.212\ F = 80.54)$$

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*Educational values 1 = no school, 2 = primary only, 3 = upto matriculate, 4 = graduate;

Read Highway Code values 1 = said they had not read it, 2 = said they had read it;

Owner driver values 1 = professional driver, 2 = driver of allocated vehicle, 3 = driver of own vehicle.

A hypothetical casual model of the 4 variables in the regression equation with their 'casual paths' is shown in Figure 7. This model was examined by carrying out a path analysis, the results of which are given in Table 6.

The total casual covariation between knowledge and the other 3 variables were all statistically significant but the level of education received by the drivers was the variable which accounted for most of the variation in driver knowledge.

The original covariation between vehicle ownership and readership of the highway code ($r = -0.26$) was found to be non-casual as all of it could be explained by the effect of education on both variables.

The differences between the mean knowledge scores for the various groups of drivers formed by combining the 3 variables, education, readership of the Highway Code and vehicle ownership are shown in Figure 8. The drivers with the highest mean score were those who were educated (had been to school), who said they had read the Highway Code and who were driving their own vehicle. Uneducated drivers had the lowest mean score and their scores were not related to whether or not they said they had read the highway code or whether or not they were owner drivers.

The variation in knowledge levels between sites were found to be related to 3 variables, the percentage of drivers who were professional ($r = -.53$), the percentage of drivers who had not attended school ($r = -.46$) and the percentage of drivers who had read the highway code ($r = 0.38$) at each site. In other words the differences between average knowledge scores found between the sites can be attributed to differences between the samples of drivers interviewed at each site on these 3 factors.

3.7. Attitude to the signs

The majority of drivers interviewed said that they thought the signs were good (95.2 per cent), 3.7 per cent thought they were very good and only 1.1% (10 drivers) said they thought the signs were poor.

Although the range of answers given to the attitude question was very small it was possible to find some factors which were related to drivers attitudes. Owner drivers were more likely to say that the signs were very

*The average speed before the signs were installed, the average speed after the signs were installed, the percentage of vehicles overtaking before the signs were installed, the percentage of vehicles overtaking after the signs were installed, the percentage of drivers who said they had read the Highway Code, the percentage of drivers who said the signs were very good, the percentage who had not been to school, the percentage who were professional drivers, the average vehicle flow per hour and the percentage of buses and trucks.

good than other drivers (6.5 per cent compared to 2.3 per cent) and drivers who new the meaning of all 10 signs were much more likely to say they were very good than the rest (41.9 per cent compared to 2.3 per cent). Attitude was also related to identification scores and drivers who correctly identified at least 4 signs were more likely to say the signs were very good than those who identified less than 4 (7 per cent compared to 2.1 per cent). Chi square tests indicated that all 3 of the above differences were statistically significant.

3.8. Readership of the Highway Code

59 per cent (533) of the drivers interviewed claimed to have read the Pakistan Highway Code.

The relationship between readership levels and 3 variables, the type of vehicle driven, owner/professional driver status and education are shown in Figure 9. Drivers of private vehicles, owner drivers (including drivers of allocated vehicles) and educated drivers (who had some formal education) were more likely to have said they had read the Highway Code (Chi Square statistically significant in all 3 cases) than their counterparts.

A path analysis of the relationships between these 3 variables and readership (Table 7) indicated that Education accounted for most of the variation in readership levels. Nevertheless, a small but significant amount of the variation could be explained by the type of vehicle driven

even when the education of the driver was taken into account. However, the relationship between readership and vehicle ownership (owner/professional drivers) was found to be spurious and the differences between readership levels of owner drivers and professional drivers was due entirely to differences in the education they had received.

3.9. Attributes of the professional driver

From the driver interviews (903) it was possible to identify the proportions of vehicles being driven by professional drivers (paid to drive a vehicle which they did not own) for each vehicle type. Using these proportions it was estimated that 51 per cent of the sample of 5,851 vehicles observed in the study were driven by such drivers. Although a wider sample is needed to generalise to Pakistan as a whole it is clear from this estimate that a very high proportion of vehicles overall are being driven by professional drivers.

The results of the interviews indicated that these drivers were less likely to have attended school than owner drivers* (43 per cent compared to 82 per cent), that they were less likely to have read the Pakistan Highway Code (49 per cent compared to 76 per cent), and that their knowledge of road signs was likely to be poorer than that of owner drivers* (48 per cent compared to 61 per cent).

*Owner drivers includes drivers with vehicles given to them by the Government or their company.

These differences are perhaps not surprising given the general levels of education, the hard working conditions of professional drivers and their low wages in Pakistan. However, ideally, one would hope that the standards of driver training and knowledge of the professional drivers were at least as high as that of other drivers,particularly as the available accident statistics demonstrate that a very high proportion of road accidents involve vehicles which were driven by professional drivers (in the Punjab Province in 1981, 65 per cent of injury accidents involved buses, trucks and wagons).

4. CONCLUSIONS AND DISCUSSION

The introduction of the road work signs and cones resulted in an average reduction in speed from 50.7 kph to 43.9 kph and an average drop in the percentage of vehicles overtaking in the areas which became no overtaking zones from 16.6 per cent to 10.7 per cent.

The signs and cones were clearly effective in bringing down the speeds at all the sites studied but they were not so effective in preventing overtaking as significant changes were found at only 5 out of 30 sities and the levels of overtaking remained quite high (up to 25 per cent) after the no overtaking signs were erected.

From the recognition tests given to drivers after the road works, it would appear that the drivers did not pay much attention to the individual signs as, on average, after correcting for guessing, the drivers only identified 1.8oout of 5 signs correctly. The best recognized sign was the direction sign which was the only sign placed in the carriageway. The others were placed on the shoulder at the side of the road. The worst recognised was the 'no overtaking' sign (only identified by 15 per cent) and it is therefore not surprising that the latter sign had a small impact on overtaking behaviour.

The amount of change in speed and overtaking levels varied considerably from site to site and it was found by regression analysis that much of the variation was related to

the initial speed of vehicles and the overtaking levels.The sites with higher speeds and higher overtaking levels experienced the greater changes. The differences were not found to be related to any differences between the driver characteristics at each of the sites such as the number of signs recognized or the number of signs known.

Recognition levels of signs also varied from site to site (0.47 to 3.07) and at sites with additional traffic controls such as traffic signals, roundabouts or railway crossings, driversidentified 0.5 signs fewer on average than they did elsewhere. This is perhaps not surprising as one would expect drivers to pay less attention to the signs when there was some form of traffic control ahead. No other reason could be determined for the site differences in sign recognition levels.

Variations in drivers' recognition levels were found to be related to readership of the Highway Code (those who said they had read the Highway Code scored 0.37 more than those who said they had not), to drivers' attitude (those who said the signs were very good scored 1.06 more than those who said they were poor) and to education (graduates scored 0.46 more than those who had not been to school).

In general the drivdrs' knowledge of the 10 road signs which they were questioned about was not good as the average number of signs known was only 5.3. The best known sign was the 'stop' sign and as this was the most common sign in the area this result is not unexpected.

Using regression techniques and path analysis it was shown that the education was the major factor related to drivers' knowledge of road signs (drivers who had been to school scored 6.1 compared to 4.2 for uneducated drivers). It was also demonstrated that drivers who said they had read the highway code did better than those who said they had not, even when education was taken into account (on average educated readers knew 1 more sign than educated non readers).

98.9 per cent of the drivers said that they thought the road work signs were good or very good and inspite of the number of signs not known by drivers it would appear that the road work signs and cones were successful in alerting drivers and bringing down their speeds. However, the small impact of the overtaking sign, the low identification scores for individual signs and the poor knowledge of signs indicate that the introduction of road signs generally in Pakistan to warn and regulate drivers may have less than the desired effect on driver behaviour and accidents. It seems likely that if a road signing scheme is to be successful,it will be necessary to make drivers pay more attention to road signs and to improve their knowledge considerably. These two aims could be achieved by including highway code questions in the driving test, improving driver training, organizing publicity campaigns and enforcing mandatory signs.

Although poor knowledge of road signs is likely to be largely due to drivers not learning about them,some lack of understanding may be due to inadequacy in the design of the

signs. Ideally drivers should be able to guess the meaning of symbolic signs even if they have not seen them before and this was clearly not the case with many of the signs used in the study. Therefore, it is recommended that the roads signs in use in Pakistan are reviewed and some research is carried out on the comprehension of different designs.

Also, in addition to providing information about the possible effect of road signs in Pakistan, this study highlighted some of the problems of professional drivers. The i erview results clearly demonstrated that professional drivers' knowledge was well below that of other drivers(48 per cent compared to 61 per cent). Also fewer of them said they had read the Highway Code (49 per cent compared to 76 per cent) and fewer of them had been to school (43 per cent compared to 82 per cent) than had other drivers. These differences could account for their high involvement in injury accidents (at least 65 per cent in the Punjab in 1981) but more research is needed to establish such relationships with accidents. Nevertheless, one would hope that the standards for professional drivers would be at least as high as those for other drivers particularly as they use the roads more frequently. As this is not the case with respect to knowledge of road signs and readership of the highway code there is evidently a need in Pakistan to introduce stricter licensing requirements for professional drivers and to improve their knowledge by improved driver training.

5. ACKNOWLEDGEMENTS

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7. APPENDIX

Interview Form

DRIVER'S TRAFFIC SIGNS KNOWLEDGE

Interviewer: _____

Place: _____

Date: _____

ONE FORM TO BE FILLED FOR EACH DRIVER

Vehicle Type:

M/C	Car	Suzuki	Wagon	Bus	Truck	Others

Driver:

Pakistani	Foreigner

Type:

Owner	Allocated	Professional

PHC Read:

Yes	No

Age when education finished:

[ ] Years

Opinton

V.good	Good	Poor	V.Poor	Don't know

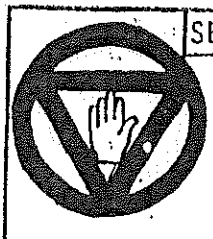
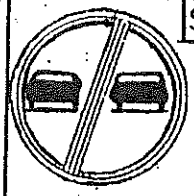
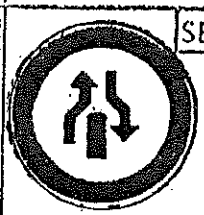
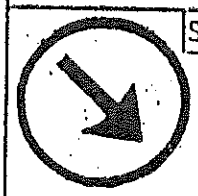
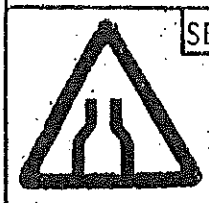
	SEEN	NOT SEEN
		
		
		
		
		
		
		
		
		
		

Table 1

Sites with significant changes in vehicles mean speeds after the introduction of signs

Vehicle Type	Number of sites with:		
	Statistically significant reuctinn in mean speed	Non-significant reduction in mean speed. Sample size over 10	Non-significant reduction in mean speed. Sample size less than 10
Car	23	7	1
Wagon	22	3	6
Suzuki	20	7	4
Bus	21	2	8
Truck	18	10	3
Motor Cycle	11	6	14

Table 2

Analysis of Variance of Factors Related to Vehicle Speeds

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance of F
Main effects	256139.4	7	36591.3	319.8	0.001
Site (urban/rural)	69611.0	1	69611.0	608.4	0.001
Vehicle Type	126338.8	5	25267.8	220.8	0.001
%age of signs	59560.1	1	59560.1	520.6	0.001
2 way intersections	25129.3	11	2284.5	20.0	0.001
site with vehicle type	12227.8	5	2445.6	21.4	0.001
Site with presence of signs	5926.0	1	5926.0	51.8	0.001
Vehicle type with presence of signs	4534.9	5	907.0	7.9	0.001
Explained	281268.69	18	15626.04	136.57	0.001
Residual	667282.13	5832	114.42		
TOTAL	948550.81	5850	162.15		

Table 3

Factors related to vehicle speed

Road Type	Vehicle Type		Absence/Presence of Signs	
			No Signs	Signs
Rural Roads: M = 50.2 N = 3370	1. Car	M=55.8 N=1085	M = 60.4 N = 549	M = 51.2 N = 536
	2. Wagon	M=53.4 N=351	M = 57.9 N = 184	M = 48.3 N = 167
	3. Bus	M=52.5 N=554	M = 58.1 N = 293	M = 46.2 N = 261
	4. Suzuki	M=46.9 N=412	M = 50.2 N = 222	M = 43.0 N = 190
	5. Truck	M=43.0 N=1706	M = 46.2 N = 351	M = 39.8 N = 355
	6. M/Cycle	M=42.0 N=262	M = 44.0 N = 130	M = 40.0 N = 132
Urban Roads: M = 43.4 N = 2481	1. Wagon	M=49.7 N=282	M = 52.2 N = 144	M = 47.1 N = 138
	2. Car	M=45.7 N=1045	M = 48.0 N = 524	M = 43.5 N = 521
	3. Suzuki	M=42.9 N=420	M = 44.5 N = 191	M = 416 N = 229
	4. Bus	M=41.1 N=143	M = 42.8 N = 191	M = 39.3 N = 70
	5. M/Cycle	M=37.6 N=420	M = 37.9 N = 196	M = 37.2 N = 224
	6. Truck	M=35.5 N=171	M = 39.0 N = 75	M = 32.8 N = 96

M = Mean Speed
N = No. of Vehicles

*The difference between these means is not statistically significant.

Table 4

Range of means for factors found to be related to recognition scores

Factors		Range of mean scores	
		Recognition Uncorrected	Recognition corrected for guessing
SITE	highest scoring site	3.97	3.07
	lowest scoring site	1.53	0.47
READERSHIP OF HIGHWAY CODE	readers	2.71	1.95
	non readers	2.27	1.58
ATTITUDE TO SIGNS	said signs were v.good	3.61	2.46
	said signs were poor	1.80	1.40
EDUCATION	graduates	2.93	1.96
	un-educated	2.25	1.50
Mean for all drivers	=	2.5	1.8

Table 5

Ranges of mean knowledge scores for factors found to be related to drivers' knowledge of road signs

Factors		Mean knowledge score (out of 10)
1. SITE	Highest scoring site	6.6
	Lowest scoring site	3.4
2. VEHICLE DRIVEN	Car	6.4
	Motor Cycle	5.7
	Suzuki	5.5
	Wagon	5.0
	Bus	4.9
	Truck	4.8
3. DRIVER TYPE	Owner	6.1
	Allocated	6.1
	Professional	4.8
4. READERSHIP OF HIGHWAY CODE	Readers	6.0
	Non-readers	4.3
5. ATTITUDE TO SIGNS	Signs were very good	8.0
	Signs were good	5.2
	Signs were poor	4.1
6. EDUCATION	Graduates	6.8
	Matriculates	6.3
	Primary Only	5.5
	Un-educated	4.2

Table 6

Relationships between drivers' knowledge of road signs and other factors

		Relationships*					
		Knowledge with readership of H.Code	Knowledge with Vehicle Ownership	Knowledge with Education	Radership of H.Code with Education	Veh. Ownership with Education	Readership of H. Code with Veh. Ownership
A	Original Covariation	0.36	- 0.27	0.43	0.58	- 0.49	- 0.26
B1	Direct Caused Covariation	0.17	- 0.09	0.29	0.58	- 0.49	(0.03)
B2	Indirect Caused Covariation	(0.0)	(0.0)	0.14	(0.0)	(0.0)	(0.0)
B1+B2	Total Caused Covariation	0.17	- 0.09	0.43	0.58	- 0.49	(0.03)
H-B1+B2	Non Caused Covariation	0.19	- 0.18	(0.0)	(0.0)	(0.0)	- 0.23

( ) = Not statistically significant

* = Values are parson corelations in A and Standardised beta values in B1 taken from the appropriate regression equations.

Table 7

Path Analysis of the driver characteristics related to readership of the Highway Code

	Relationships (Yule's Q)				
	Readership with Education	Readership with Veh. Ownership	Readership with Veh. driven	Veh.Ownership with Education	Veh.driven with Education
Original Covariation (Q)	0.93	0.54	0.48	0.72	0.53
Differential Covariation (Q Diff.)	0.93*	(0.02)**	0.20**	0.64	0.37
Differential Covariation (Q.Diff.)	0.93	0.70	0.58	0.75	0.59

*Controlling for either vehicle ownership or vehicle driven

**Controlling for education.

Distances from works

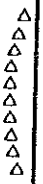
200 -- 400 metres

150 – 350 metres

50 – 100 metres

(In Urdu) End

By the first cone



Cones

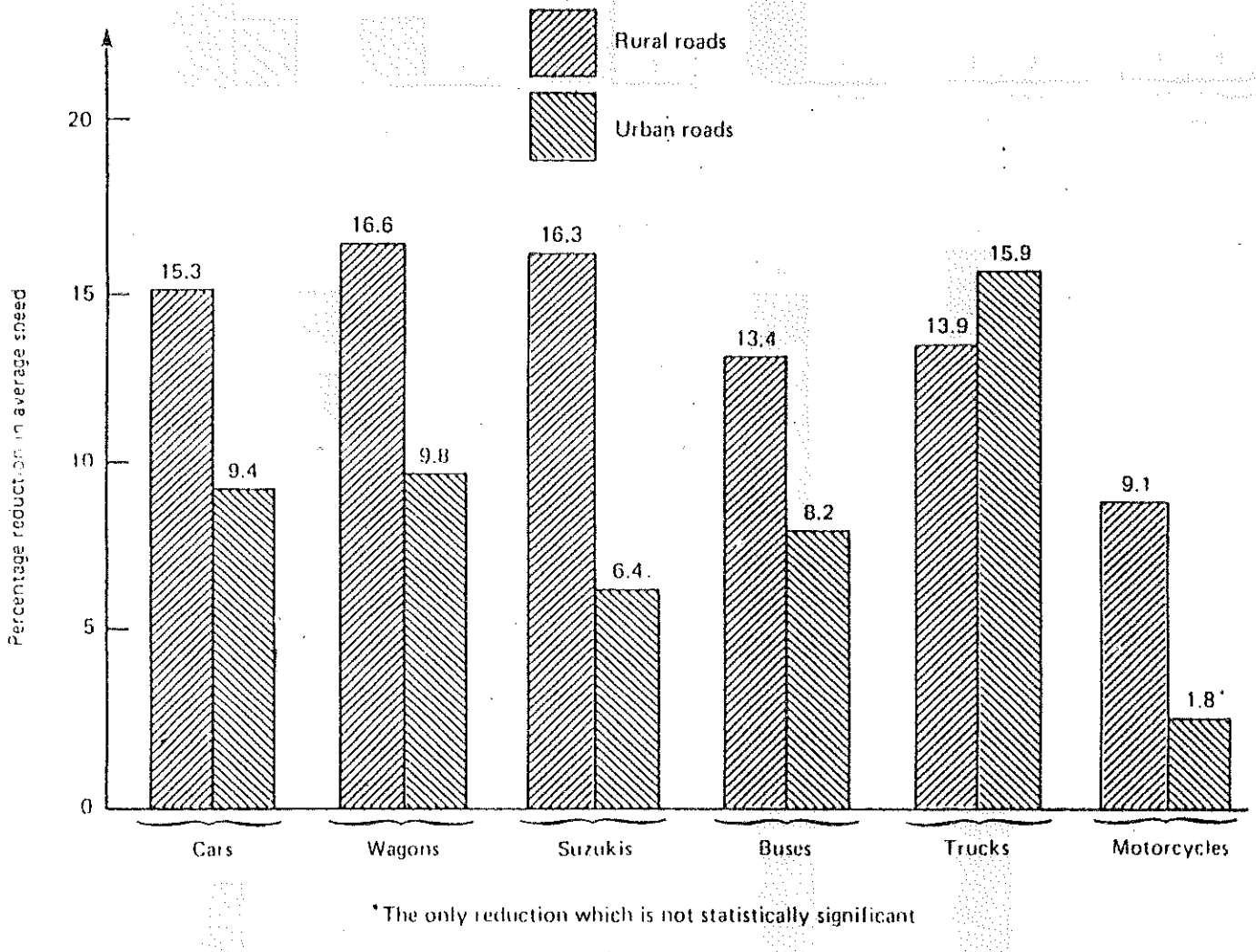
End

At the end of the works

At the end of the works

Fig. 1. Layout of signs and cones

Fig. 2 Experimental roadwork sign



*The only reduction which is not statistically significant

Fig. 3 The percentage reduction in average speeds after the introduction of road works and signs

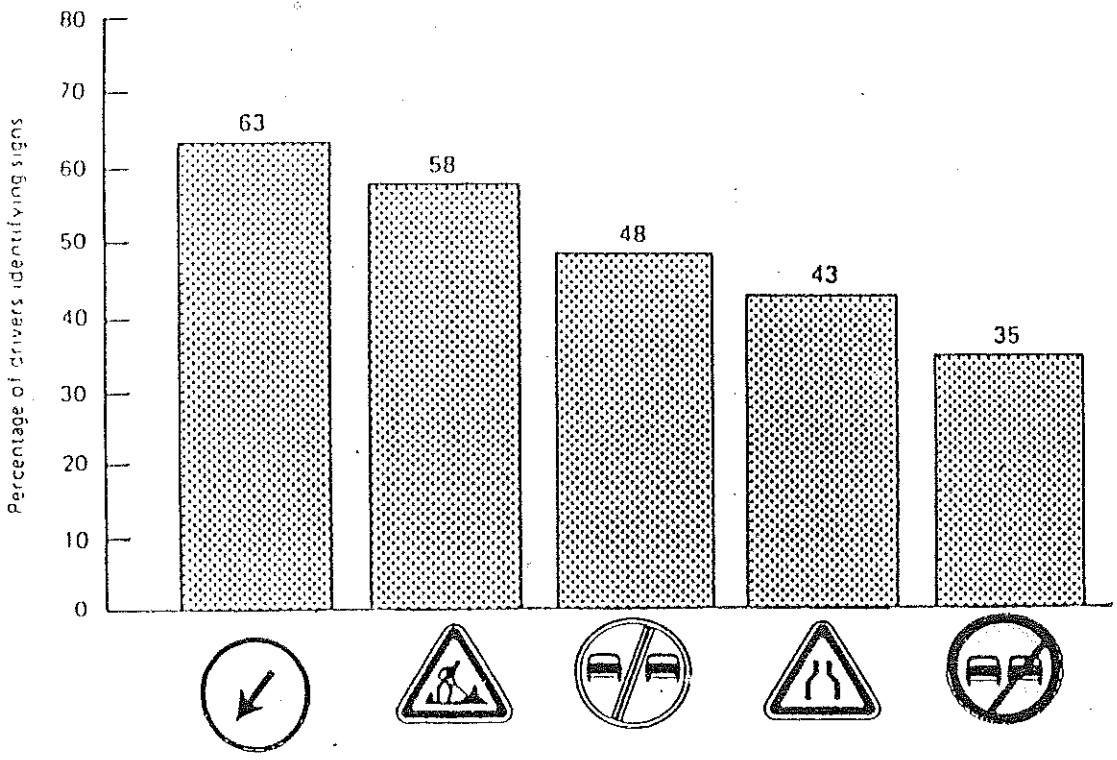


Fig.5 Identification levels for different road work signs

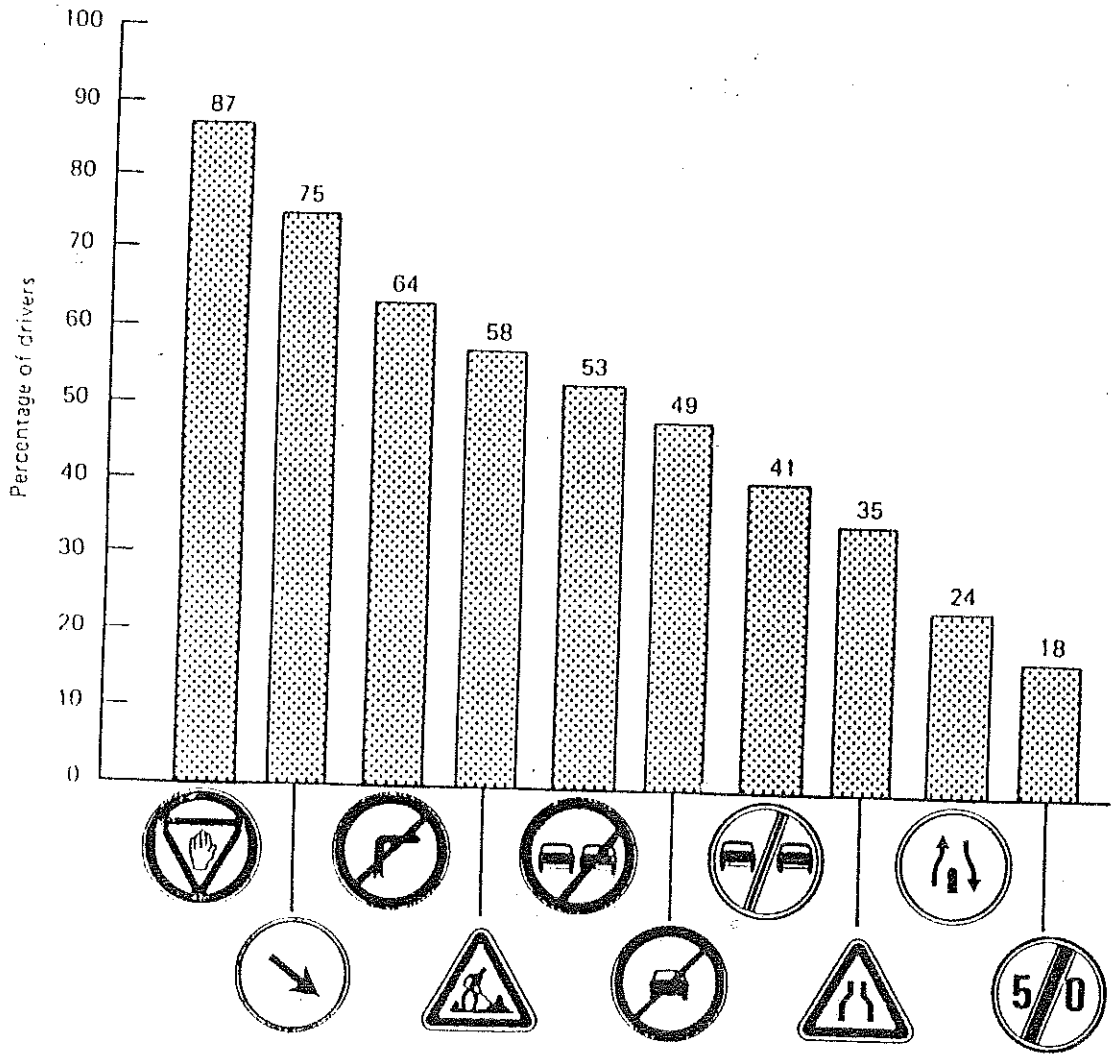
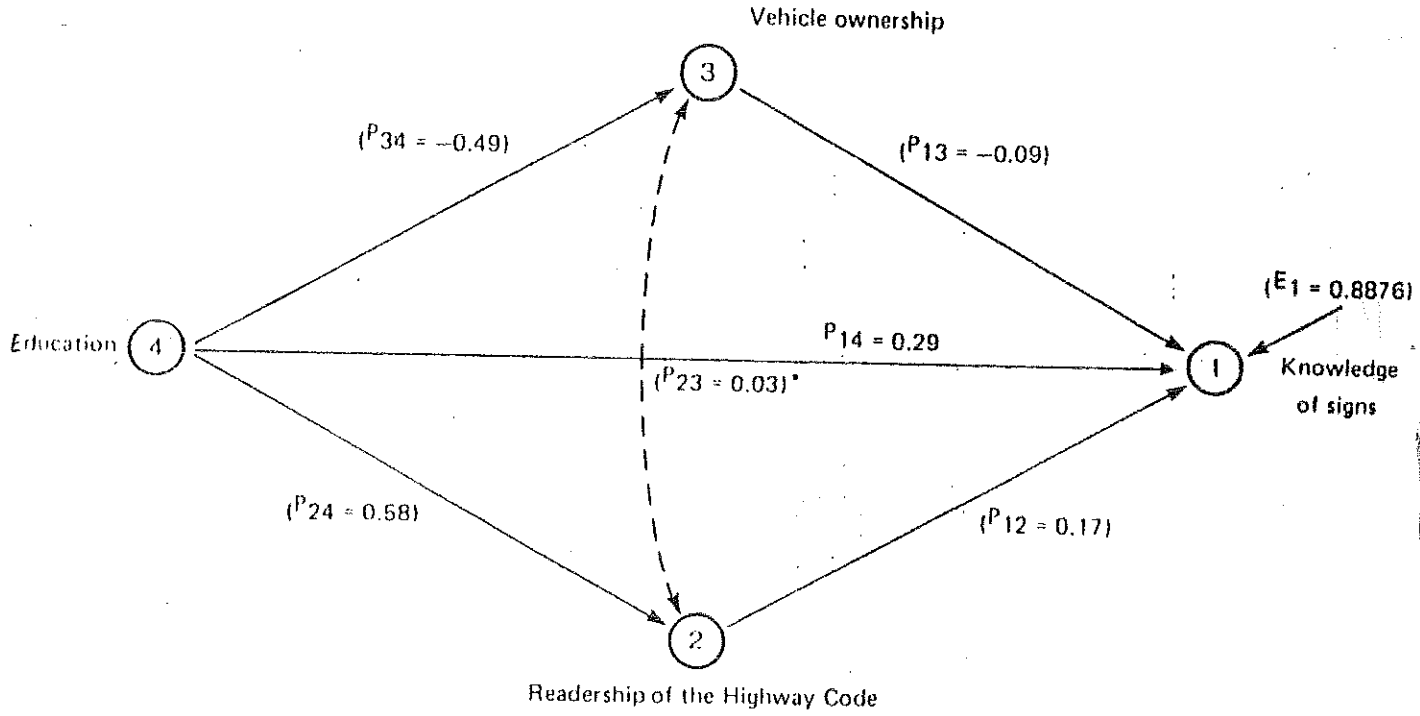


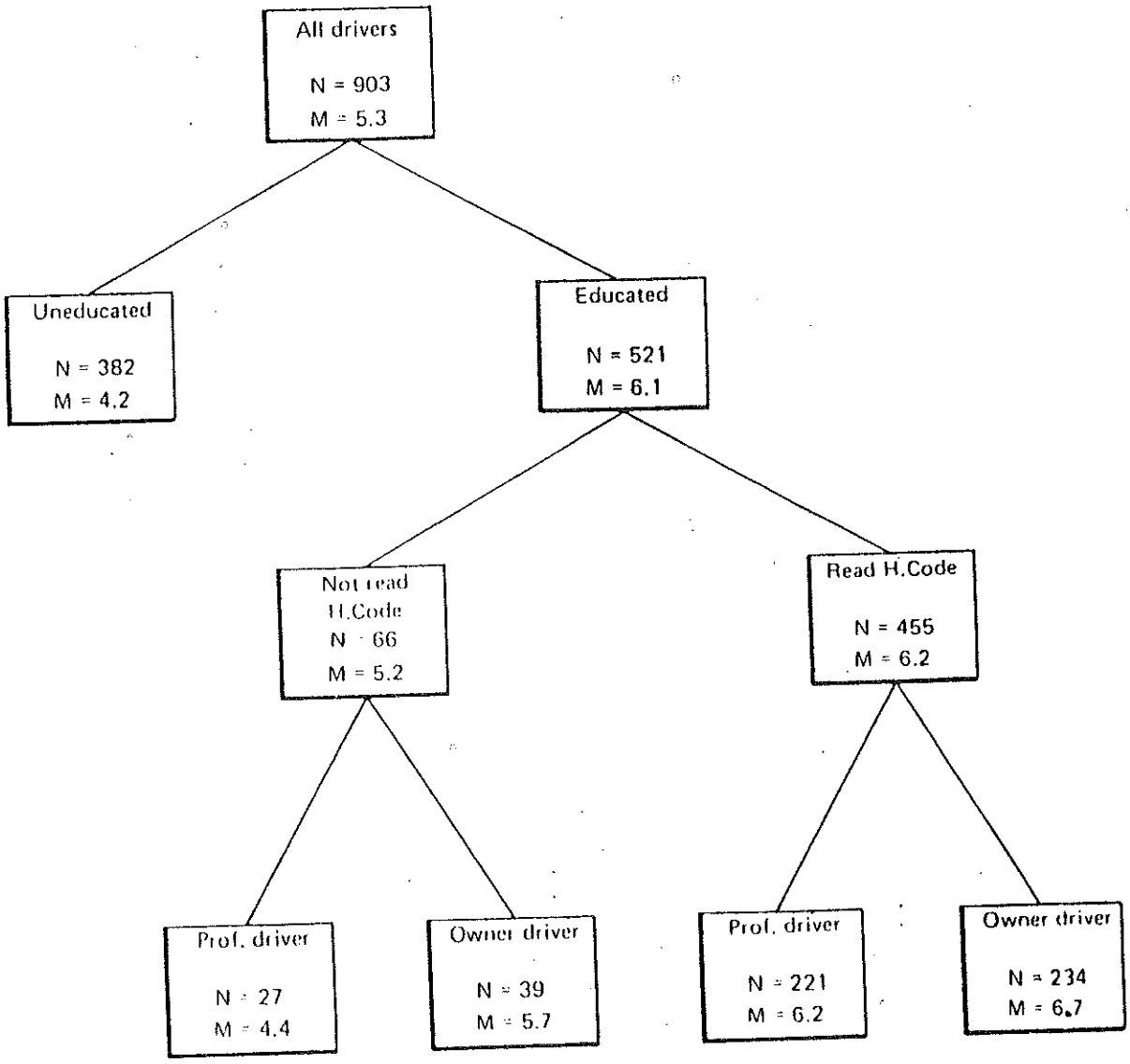
Fig. 6 Percentage of drivers who gave correct meaning of each sign



* = not statistically significant

( ) figures from table 6

Fig. 7 Path analysis model of drivers knowledge of road signs



Only statistically significant differences have been shown (T – tests)

N = Number in group

M = Mean knowledge score

Fig. 8 Factors related to drivers knowledge of road signs

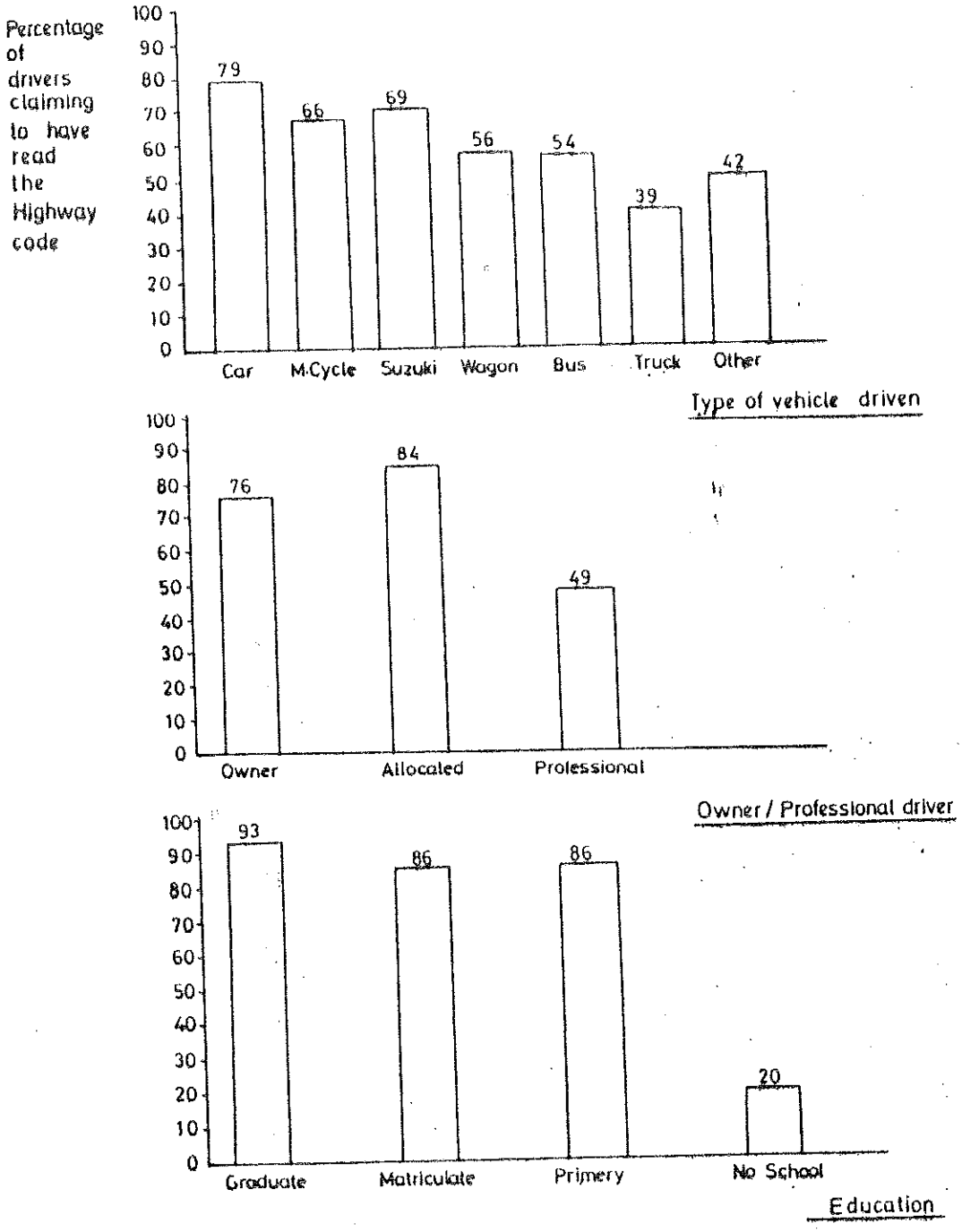


Fig:9 Readership levels for different driver characteristics.